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Shrestha, S; Thompson, B; Toma, L; Ferreira, JG; Barnes, AP

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An economic assessment of ecological practices in Scotland

Authors

Shailesh Shrestha¹, Bethan Thompson, Luiza Toma, Joana Ferreira, Andrew Barnes

Summary

An early adoption of ecological management practices by farmers is a potential route to achieve sustainable and greener goals for agriculture. This briefing note outlines an economic assessment of four different ecological practices on Scottish livestock farms. The ecological practices used are; ecological area, reducing farm inputs, organic adoption and agro-forestry.

The results suggest that ecological area and reduced farm inputs have potential financial benefits on farms and can be easily adopted by farmers. The organic and agro-forestry systems, however, require capital investment to establish and hence provide a challenging prospect of adoption without a provision of financial support

¹ *Department of Rural Economy, Environment and Society, SRUC, West Mains Road, Edinburgh, UK*

1.0 Introduction

The shift from a conventional agricultural production system towards a sustainable and greener agricultural production is evident in the EU in recent years (EU, 2019). In Scotland, the Scottish government has put forward a long term Climate Change Plan to achieve a cleaner, greener and healthier Scotland by 2032 (SG, 2018). Adaptation of agro-ecological management practices by farmers is considered to be a potential approach to support these plans (Wezel et al., 2014; Vermunt et al., 2020; Teixeira et al., 2021). Many studies have been conducted to analyse the biophysical and socioeconomic impacts of such management practices on agriculture production (Izquierdo et al., 2003; Chappell and LaValle, 2009; Migliorini et al., 2018). However, a critical issue is the economic impact of adoption of these practices. This brief examines, through the use of a farm economic model, the potential agro-ecological practices in Scotland and their financial impact on farming businesses.

2.0 Method

This work followed up the large scale farmer survey that was reported in earlier briefs (Thompson et al., 2021²; Barnes et al., 2021³). Among the surveyed farmers, 31 livestock farmers responded with detailed economic information on farms. Of these 22 farms have only livestock (beef and sheep) production system and 9 farms have livestock mixed with a crop production system.

A farm level economic model, ScotFarm (Shrestha, et al., 2020; Shrestha, et al., 2018; Ahmadi, et al., 2015), was used to analyse the economic impacts of the management practices. The model is a dynamic optimising model based on farming system analysis. It maximises farm net profit within limiting constraints, such as land, labour and feed requirements. The model has been used to compare farm management options in the past (Eory et al., 2012; Glenk et al., 2012; Lampkin et al., 2021).

Four ecological management practices were identified and used as alternative management scenarios in this work. These alternative agro-ecological management practices are considered to be the most practical practices that livestock farmers in Scotland could adopt. These alternative management practices are;

- i. Setting aside an ecological area (*'Ecoland'*): This practice requires a farm to set aside some part of agricultural land for ecological purposes. The land is not used for any farm production. This affects the farm production adversely but reduces farm inputs.
- ii. Reduction of farm inputs (*'InpCosts'*): Under this practice, a farm is required to reduce inputs such as fertiliser, sprays, veterinary and labour. It is assumed that small reduction in inputs do not lead to significant decrease in farm profit.
- iii. Conversion to an organic system (*'Organic'*): This practice allows a farm to move from conventional system to an organic system of production. This requires an initial costs of conversion for first year and maintenance costs in subsequent years of production. Farms though benefit from lower input costs and premium price for the farm products.
- iv. Planting trees (*'AgroForestry'*): Farms allows some part of agricultural land to plant trees. This practice also requires initial establishment in the first year and maintenance costs in subsequent years of production. The farm generate revenues from trees after some year based on a type of the trees planted.

² Available at: <https://zenodo.org/record/5356877>

³ Available at: <https://zenodo.org/record/5524736>

Further assumptions specifically to the modelling scenarios are listed in Table 1 below.

Table 1: The ecological management options and their assumptions

Agro- ecological management scenario	Assumption	Additional information
i. Ecoland	10% of utilized agricultural area is left and maintained as an ecological area	
ii. InpCosts	Farms will reduce inputs such as fertiliser, sprays, veterinary and labour use	<ul style="list-style-type: none"> • Input costs reduced by 10% • Productivity improvements will lead to no impact on production levels
iii. Organic	Farms convert all activities to organic system.	<ul style="list-style-type: none"> • Initial conversion costs of £500/ha • Maintenance cost of £55/ha for grassland and £8.50/ha for rough grazing land • Reduction in variable costs (15% for crop and 7% for livestock) • Reduction in stocking rate by 20% • Farm receive a premium price for crops (+10%) but no change for livestock price • No farm support payment for conversion to organic system
iv. AgroForestry	10% of utilized agricultural land is used to plant trees	<ul style="list-style-type: none"> • 50 trees/ha • £8556/ha establishment costs (includes planting and maintaining trees) • Generates a revenue of £373/ha from the 5th year of planting • No farm support payment for conversion to agro-forestry system

Adapted from Lampkin et al. (2021)

The optimised farm net profits under these alternative management scenarios are compared with the farm net profit under a baseline scenario to analyse their economic impacts on Scottish livestock farms. These impacts were further analysed based on farmers' responses to a number of agro-ecological aspects, namely, their participation to agro-ecological schemes, use of chemicals to control pests and diseases and allowing fallow land on farms. Unfortunately, the sample size of such responses was very small to conduct any statistical analysis, nevertheless, the results provide some understanding on famers' perception towards adopting agro-ecological management practices.

3.0 Results

Figure 1 shows the average farm net profit under a baseline scenario and four alternative agro-ecological management scenarios. The results suggest that there is a small but positive impacts of EcoLand and InpCosts management options. Here farm net profit increased by 2% and 3% respectively.

The livestock numbers were not affected and farms benefitted from lower variable costs under these options. The other two management options, Organic and AgroForestry, however, show a negative impact where farm profits drop by 6% and 9% respectively compared to the baseline scenario. The initial capital investment to convert the farming activities, land and maintenance over the years contributed to this reduction in farm net profit on an average Scottish livestock farm.

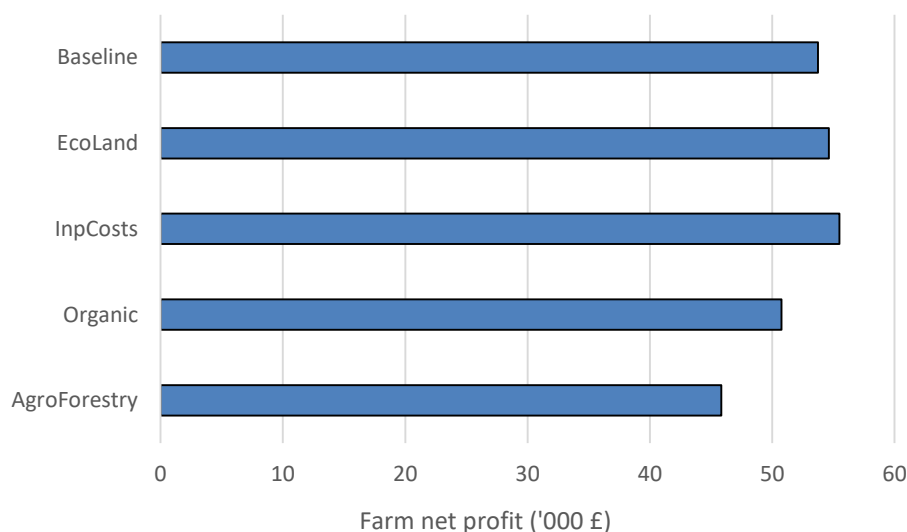


Figure 1: The average farm net profit under the baseline and 4 alternative ecological management options

The extent of impacts of these management options, however, will differ, depending on individual farms. In general, all farms benefited from reduced input costs under the EcoLand and InpCosts options (Figure 2). Under the EcoLand scenario, farm utilized agricultural area is reduced by 10% which lowered costs of fertiliser and spraying on farms at varying levels. This drives the profits slightly up compared to the baseline scenario.

However, a small number of farms with larger crop production showed a negative impact on farm net profit when 10% of arable land was left out of production. In addition, several farms with higher input costs which benefitted the most under the InpCosts scenario with up to 18% increase in farm net profit.

Under the Organic management option, a majority of farms (81%) showed a negative impact on farm net profit. This ranged from -1% to -24% across the sample. But there are few farms which benefited (with an increase in farm net profit up to 14%) from lower input costs and premium price for their crop products when they moved to an organic system.

The AgroForestry option is the only management option which has negative impact on all sampled farms. The reduction in farm net profit on these farms ranged from 2% to 28% when farms converted to an agro-forestry system.

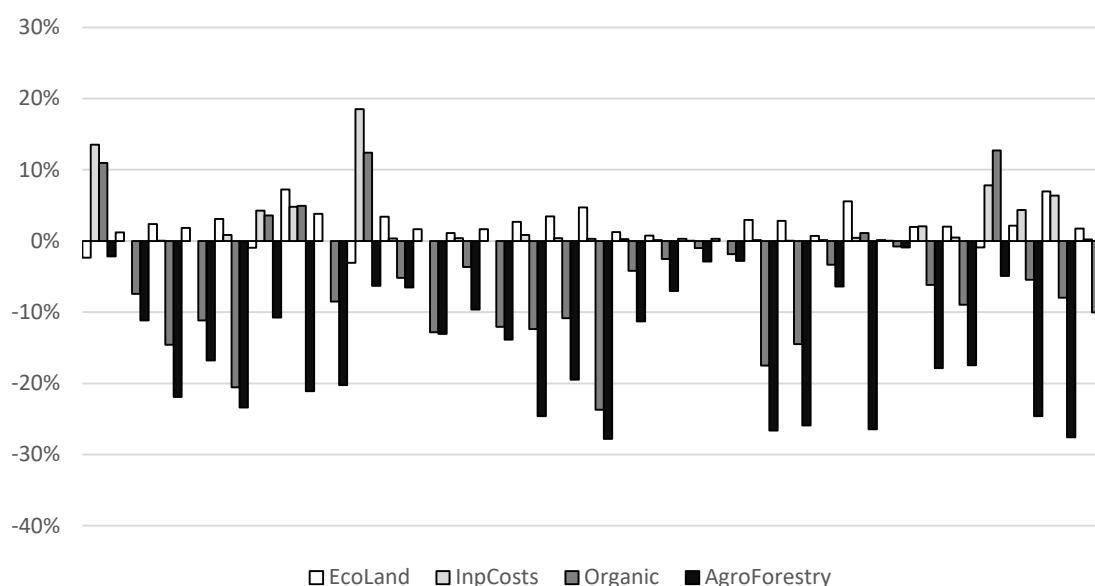


Figure 2. Percentage change in farm net profit under alternative scenarios compared to the baseline scenario (individual farms on x-axis)

The impact of these alternative scenarios can be analysed further by separating all sampled farms into two groups based on the extent of the impacts; a group of farms with beef and sheep productions and another group of mixed farms with beef, sheep and crops production.

As shown in Table 2, the beef and sheep only farms are comparatively smaller, less intensive farms with higher rough grazing land. These farms also generate lower net profits. In contrast the livestock and crop mixed farm group are larger and more intensive. They generate 1.6 times more net profit on average than livestock only farms. The EcoLand, InpCosts and AgroForestry management options had similar but to a varying extent of impacts on farms in both farm groups.

However, the organic management had the opposite effect within these two groups. The group of farms mixed with livestock and crop showed a positive response to the organic management option whereas livestock only farms had a very negative impact of converting to organic system.

Table 2: Differences in farm characteristics and net profits between livestock production only and farms and farms with both livestock and crop productions

	Beef and sheep system only (22 farms)	Beef and sheep mixed with crops (9 farms)
Farm characteristics		
Arable land (ha)	4.0	140.2
Grassland (ha)	100.4	132.4
Rough grazing land (ha)	112.1	4.4
Livestock units	37.6	84.7
Farm net profits		
Baseline (£)	46,325	71,830
EcoLand*	2%	2%
InpCosts*	0%	7%
Organic*	-10%	3%
AgroForestry*	-15%	-15%

*Percentage change compared to the baseline farm net profit

There was a small number of farmers (11 in total) who responded to have participated in an agri-environmental scheme (AES). There is not a big difference between farm net profit under the baseline, EcoLand and InpCosts scenarios, although the Ecoland option showed slightly larger positive impact on farms which had participated in AES. Conversely, the Organic and Agro-Forestry options had a higher negative impact on farms participating in the AES.

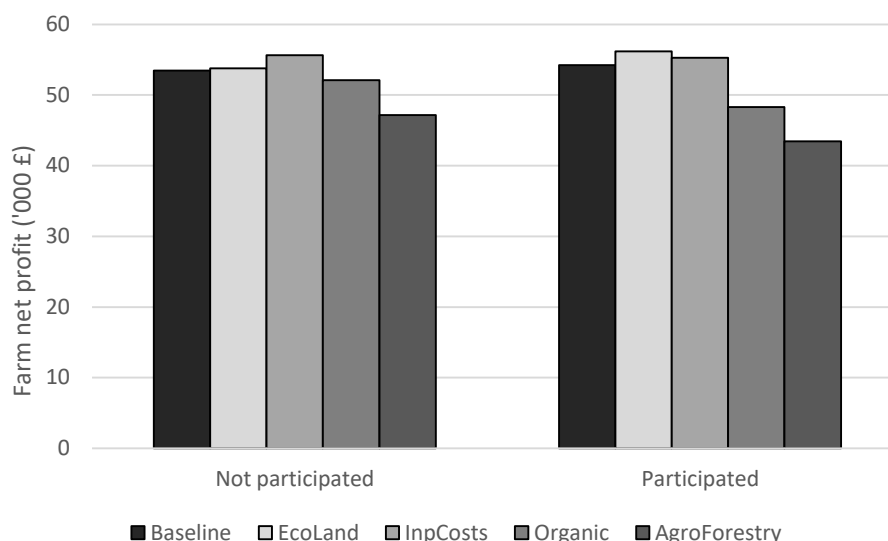


Figure 3: Differences in farm net profit under different scenarios based on farmers response to participation in agro-environmental schemes (AES)

Similarly, an examination on farmers' responses to chemical use on farm showed that farms using chemical inputs to control pests and diseases had substantially higher farm net profit. However only 7 farms confirmed the use of chemicals on farms and rest of farms in the survey did not respond to the query. All of these farms also responded to reducing chemical use on their farms in the future suggesting they are more open in adopting at least one of the ecological management practices.

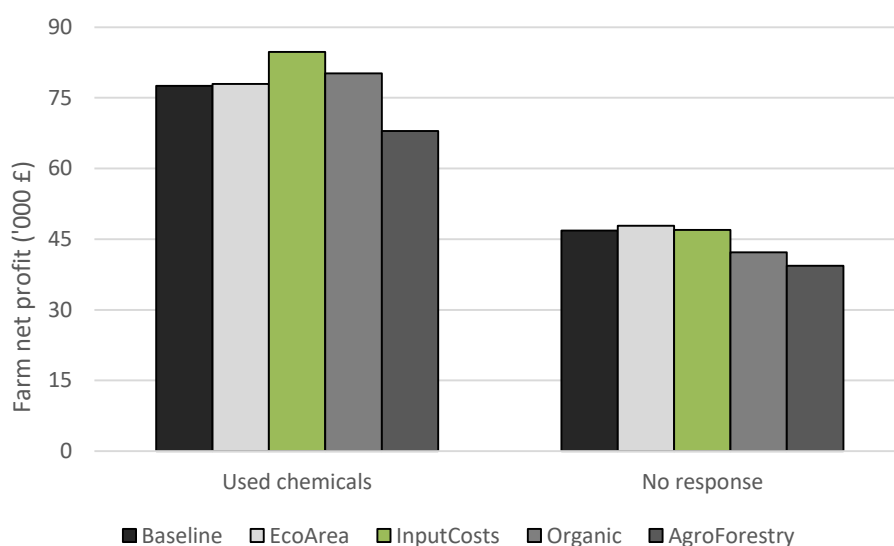


Figure 4: Differences in farm net profit under different scenarios based on farmers response to use of chemicals to control pests and diseases on farms

Similarly, 7 farmers responded to the fallow land query in the survey. Out of these only 4 farms confirmed allowing fallow land on their farm. The response to different ecological management options were identical in both sets of farms except for organic system which showed a negative response on farms which did not use fallow land on their farms (Figure 5). These are mostly livestock only farms and as suggested earlier they had a negative impact of converting farm to organic due to initial conversion and later maintenance costs.

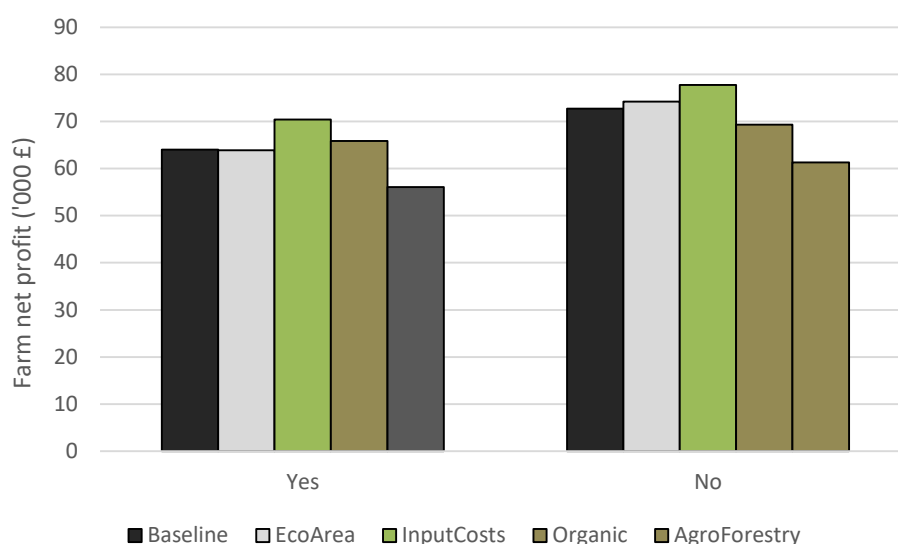


Figure 5: Differences in farm net profit under different scenarios based on farmers response to allow fallow land on farms

4.0 Summary

This brief presented an economic assessment of four alternative agro-ecological management practices for Scottish livestock farmers.

- Allowing ecological area and reducing farm inputs clearly benefitted most of the farms as we assumed the production of the farms staying the same under these practices but input costs are reduced. There are many farms who have already adopted these practices in Scotland.
- The conversion to organic and agro-forestry system is comparatively a bigger change to most of the farms. The initial establishment costs and subsequent high maintenance costs mean that these farms need some capital investment to adopt these practices. There is an increase in farm profits due to organic premium price farms receive and additional revenues trees generate, the high cost of conversion led to a substantial reduction in farm profits under these two management practices for most of the farms and hence present as a big obstacle to uptake these practices.
- Changing the rationale for support, and engaging in promotion of wider agro-ecological policies should focused on the economic losses these practices may bring,

but also changes in supply chains and consumers to recognise the benefits of these systems would also be needed to support a change⁴.

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⁴ There is an organic conversion payment available in Scotland for grassland, of £140/ha for first two years and £55/ha for next 3 and for rough grazing land, £12.5/ha for first two years and £8.5/ha for next 3 years. This payment, however, is not included in this work to examine the sole impact of conversion to organic system on farms.



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For further details please contact:

Shailesh Shrestha 

 : shailesh.shrestha@sruc.ac.uk